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Methods of Increasing Effectiveness of Satellite Communications Systems

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[Text] The report by the Odessa Communications Electrical Engineering Institute imeni A.S. Popov [OEIS] entitled "Development of Effective Coding and Modulation Methods in Satellite Communications Systems" and conclusions drawn by the GNTU [not further identified], GKRU [not further identified], Radio Scientific Research Institute [NIIR], and Moscow Communications Electrical Engineering Institute [MEIS] were discussed at the June 1987 meeting of the Scientific-Technical Council of the USSR Ministry of Communications.

Using corrective codes is one effective way of increasing the noise-immunity and carrying capacity of satellite communications systems. Theoretical and applied research and development [R&D] of codecs and codems that can serve as the basis for the wide-scale introduction of noise-immune coding in satellite communications system equipment has been conducted at the OEIS. The following are some specified achievements of these R&D efforts: the theoretical foundations for increasing the information effectiveness of communications systems and different methods for coding and decoding packet codes; methods of finding optimal codes for different channels and using them to compile code tables; codes that are transparent to the phase ambiguity in a channel; different groups of multiposition signals; the foundations for implementing packet codes for different speeds, including in integrated microcircuits and microprocessors; the theoretical bases for designing cascade systems (codems) using corrective codes and multiposition signals; and a code for a 7/8 packet code at a speed of 60 Mbit/s for digital television broadcasting.

Codems that make it possible to obtain a power gain (compared with FM_4) without reducing the specific speed or to increase the specific speed without reducing the power efficiency are being researched and developed for future satellite communications systems.

The following have been jointly developed with the NIIR: a 512-kbit/s modem for biorthagonal signals that doubles the carrying capacity of a retranslator trunk and a packet code codec that uses a Viterbi algorithm that operates at speeds between 512 and 2,048 kbit/s and provides a power gain of 3 to 5 dB with an error probability of 10^{-5}. A codem for MDVR-60 equipment that provides a power gain of 3 dB when $p = 10^{-5}$ has been developed on the basis of MDVR-40 equipment.

The scientific-technical council decided to approve the OEIS's work pertaining to increasing the effectiveness of satellite communications systems, introducing their scientific research into the instructional process on a wide scale, and training scientific personnel.

It was recommended that research in the field of using optimum methods of noise-immune coding and modulation to increase the effectiveness of high-frequency digital radio relay communications systems be expanded.

Our journal's editorial staff is planning to issue a thematic collection, "Increasing the Effectiveness of Satellite Communications Systems," in which articles on topics discussed at the scientific-technical council will be published.

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Prospects for Developing and Introducing Domestic Digital Transmission Systems

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[Article by Yu. V. Surin]

[Text] The ever-increasing role of communications in the country's economy has made it necessary to expand and accelerate the use of the latest scientific and technical progress. Special attention is being paid to digitizing primary communications networks by introducing digital transmission systems with different channel capacities that operate along metal and optical cables.

A family of digital transmission systems that used metal cables and that was intended for use in deriving all forms of communications networks was developed during the 11th Five-Year Plan. The family included the following systems: IKM-15, Zona-15, and IKM-30 for rural systems; IKM-30 for municipal systems; IKM-120 and IKM-480 for local systems; and IKM-1920 for trunk systems. The industrial enterprises that produced communications equipment were faced with the task of putting the digital transmission systems that had been developed into series production, whereas the organizations that maintained and constructed communications equipment were faced with the task of introducing these digital transmission systems in the communications lines that were being rebuilt and redesigned. These tasks were not always accomplished successfully, however.

The most favorable situation came about when digital transmission systems were introduced in municipal and rural networks. The IKM-15 equipment, which industry produced in significant quantities, thus has good quality characteristics. This has made it possible to increase the number of channels derived with the help of this system each year. The Zona-15 digitals transmission system is produced in lesser quantities, and the personnel at enterprises using this system have had serious complaints with respect to the equipment's quality parameters.

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The development of rural networks will proceed through the ever-expanding use of 15-channel digital transmission systems. Rural telephone station [STS] channels will also be derived by using systems with 30 channels or more.

Unified line path [LT] equipment for the TsUKAT STS that will make it possible to create 15- and 30-channel tracks is now being developed. The IKM-30S system, which is an updated version of the design used in the IKM-30-4 system, will be used together with the TsUKAT equipment to create the latter. It is economically feasible to derive the communications lines of high-channel capacity STS by using adaptive differential pulse-code modulation [ADIKM] equipment. ADIKM-30x2 equipment thus makes it possible to double the carrying capacity of the line paths of IKM-30S or Zona-15 digital transmission systems by configuring additional converter equipment without redesigning the 30-channel line paths and while preserving the length of their regeneration sections.

The IKM-30 equipment that was developed at the end of the 1970's has received wide-scale dissemination. The increase in its quality characteristic requirements, which was caused by the high operating expenditures necessary to maintain it, made it necessary to develop a new-generation IKM-30 system. Thanks to the use of a new component base, the equipment complex that was created for the IKM-30-4 municipal telephone network had significantly improved technical and economic indicators. Its electric power consumption was reduced, the area occupied by the equipment was reduced, and the technological feasibility of producing it increased sharply. The special service equipment that was developed for inclusion in the complex makes it possible to reduce the time needed to service the entire complex so as to make it easier to find failures, both in the terminal equipment and in the line path equipment. Municipal telephone networks are anxiously awaiting this equipment; however, it introduction into industry is proceeding slowly.

A new transmission system for the IKM-120-4/5 municipal telephone network that is intended to operate on symmetrical cable is being developed on the basis of the design of the IKM-30-4 digital transmission system and the design decisions made in it. The equipment includes channel-forming equipment and corresponding devices from the IKM-30-4 digital transmission system, unified service equipment, and telemetry and supervisory indicator and teleautomatics devices and containers that are to a large degree unified with IKM-30-4 equipment. The presence of the aforementioned equipment will make it possible to reduce the time needed to put IKM-120-4/5 equipment into series production, introduce it into communications networks, replace obsolete KAMA and KRR equipment, and increase the effectiveness of using symmetrical cables.

The number of channels in local communications networks that have been derived with the help of digital transmission system equipment is also increasing. This refers primarily to lines based on symmetrical cable with IKM-120A equipment, which has been produced since 1982. The majority of IKM-120 digital transmission system complexes, beginning from its first prototypes, operate in the Lithuanian SSR. During the years that this equipment has been in operation, the possibility of using it to help create a branched communications network based on the wide-scale use of digital channel and track through-line operation has been confirmed. Compared with the practice of deriving such a network by using analog equipment, this method results in a significant reduction in the amounts of equipment that must be installed. The low quality of the IKM-120A equipment that is being manufactured, however (especially the line regenerators and teleautomatics and telemetry and supervisory indication devices) has caused operating personnel to develop a negative attitude toward this equipment.

Collectives of developers and manufacturing enterprises are working to improve the quality of the line path equipment in the IKM-120A system; however, they have been unable to completely eliminate all of its shortcomings. The quality with which the line path regenerators' containers is manufactured has particularly suffered. The devices are characterized by leakage, deviations from insulation resistance norms, insulation breakdowns, etc.

New IKM-120U secondary digital transmission system equipment, which is in many respects superior to IKM-120A equipment from the standpoint of production and operating indicators, will replace the IKM-120A digital transmission systems. The IKM-120U digital transmission system has been designed by using a modern component base and by using series-produced integrated circuits with low and medium degrees of integration and specialized large-scale integrated circuits [BIS]. In the IKM-120U the primary and secondary splices are in complete conformity with domestic and international requirements, the maximum length of a remote feed section has been increased, the limits of the line regenerator's equipment's lightning-resistance has increased.

Unfortunately, the process of preparing the equipment for series production is proceeding slowly. For a long time developers have not implemented the comments and suggestions that have been made when the equipment was being tested and accepted. Considering the experience of the production and introduction of the IKM-120A system, the adjustment lot of the IKM-120U system will be checked carefully on a very long line.

The fact that the production of testing and measurement equipment has still not been debugged has caused additional difficulties in the series production and introduction of the aforementioned equipment.

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In the 12th- and 13th-Five-Year-Plans collectives at industrial enterprises and at the enterprises that use digital transmission system equipment for communications networks will be faced with large-scale tasks related to beginning the series production of and installing future digital transmission system equipment that operates by using symmetrical (the IKM-480) and coaxial cable (the IKM-480x2 and IKM-1920x2) as well as the families of digital transmission systems that use optical cables. The tasks entailed in creating digital zones, and eventually a countrywide digital communications network, will also be great.

It should be noted that networks are being equipped with digital transmission systems in close cooperation with specialists from scientific research institutes and enterprises that produce and use this equipment as well as with workers in the apparatus of the interested ministries.

The tasks for today are to sharply increase the quality of digital transmission systems by improving their component base and production technology; improve the efficiency of using communications cables, thereby increasing the carrying capacity of digital transmissions systems; develop a system for centralized servicing of digital transmission systems by stipulating the components in this system in the design of the equipment itself; and boost the creation of fiber optic digital transmission systems by paying special attention to the economy of unmanned regeneration point [NRP] feed systems and to effective methods of laying and assembling optical cables.

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Evaluating Feasibility of Using Primary and Secondary Digital Transmission Systems Based on Type T2 Cables

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[Article by V.I. Petrov, D.A. Podberezin, V.N. Spiridonov, and Ye.I. Yatsyna; first two paragraphs, ELEKTROSVYAZ introduction]

[Text] Primary and secondary digital transmission networks [TsSP] operating along circuits of type T and TP low-frequency symmetrical cables [SK] [1] and type MKS high-frequency symmetrical cables have been used extensively in municipal telephone networks [GTS]. In addition, significant amounts of type TZ low-frequency long-distance communications symmetrical cables have been laid in the country's communications network.

Considering the great significance of the problem, it seems advisable to evaluate the possibility of using digital transmission systems that are based on these types of cables. Such an evaluation is especially important because, in some places, attempts are being made to organize digital transmission systems with pulse-code modulation along TZ cables (in accordance with All-Union State Standard [GOST] 5008-73, which includes a reference to the possibility of conducting such operations). No practical research in this direction has been conducted to date.

The conditions for the transmission of a group digital by means of a primary digital transmission system with a speed on the order of 2 Mbit/s along circuits of type TZ cables have been studied by finding the maximum allowable length of the elementary cable section (l) in multipair symmetrical cables depends on the number of simultaneously operating primary digital transmission systems in the cable (N) averaged across the entire group of circuits exerting an effect, the value of the transient attenuation in the closer end of the cable ($-/A_0$), the mean-square deviation of the value of the transient attenuation (sigma), and the attenuation factor of the cable circuits at the half-clock frequency (α). It may be found according to the formula

$$l \leqslant \frac{\bar{A}_0 - \sigma - 24,7 - 10 \lg N}{\alpha},$$

where $-/A_0$, sigma, and α are expressed in dB.

Because low-capacitance TZ cables (four- and seven-quadded) have been the most widely used, all computations and research dealt with them.

It is known that in line paths [LT] of digital transmission systems used in municipal telephone networks, two or three pairs of cable are allocated to derive low-frequency service communications and for telemetry and supervisory indication [1]. This means that it is not possible to derive more than two bilateral line paths along pairs of four-quadded cables or more than five along pairs of seven-quadded cables. In accordance with (1), the maximum allowable attenuation of the elementary cable section for four-quadded cable is

$$\alpha l_{(4)} = \bar{A}'_0 - \sigma' - 27,7,$$

and for seven-quadded cable, it is

$$\alpha l_{(7)} = \bar{A}''_0 - \sigma'' - 31,7,$$

where $-/A'_0$ and $-/A''_0$ are the mean values of the transient attenuation at the closer end between pairs of

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